

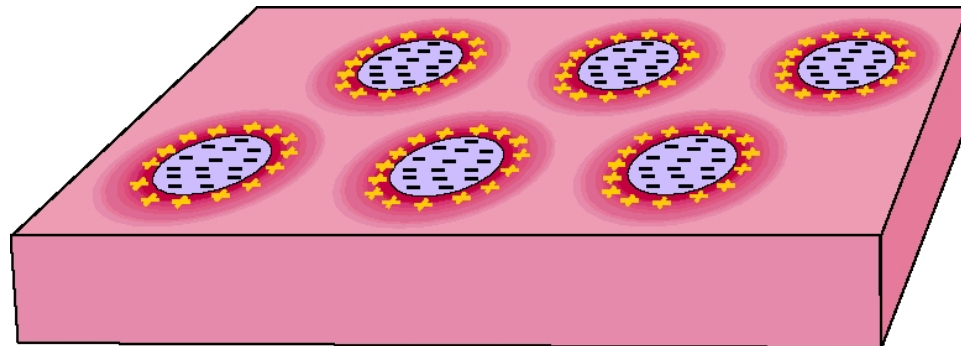
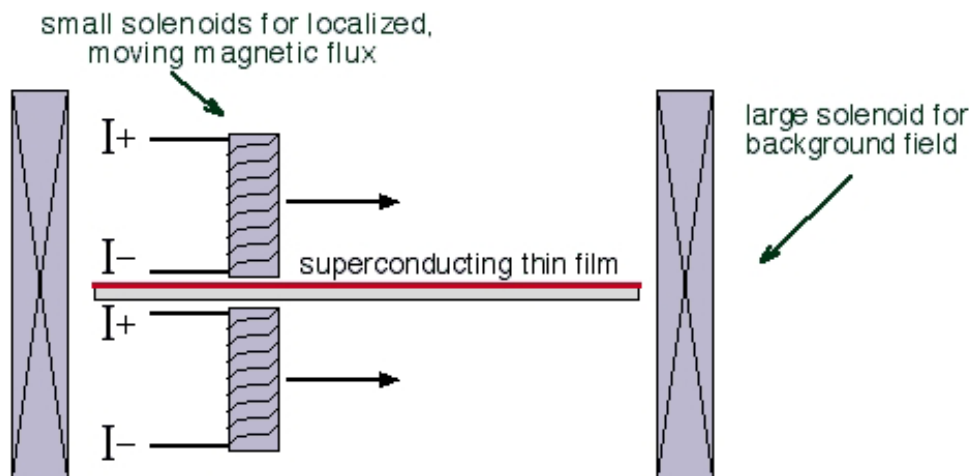


Measuring the Vortex Charge

Jeffrey Clayhold, Clemson University, Clemson, South Carolina DMR-0102736

The amount of the electric charge deficit inside the core of a vortex in a superconductor depends strongly on the nature of the superconductivity. In the standard Bardeen-Cooper-Schrieffer (BCS) theory of superconductivity, only an immeasurably small charge difference should arise. Many alternate theories of the high-temperature superconductors predict that a bigger charge imbalance exists between the center of the vortex and the region outside. The vortex charge has not yet been measured in any superconductor because the vortices are so small, the superconductor short-circuits the electric fields, and the charge difference is tiny.

Key Innovation:
two magnetic fields, no external current



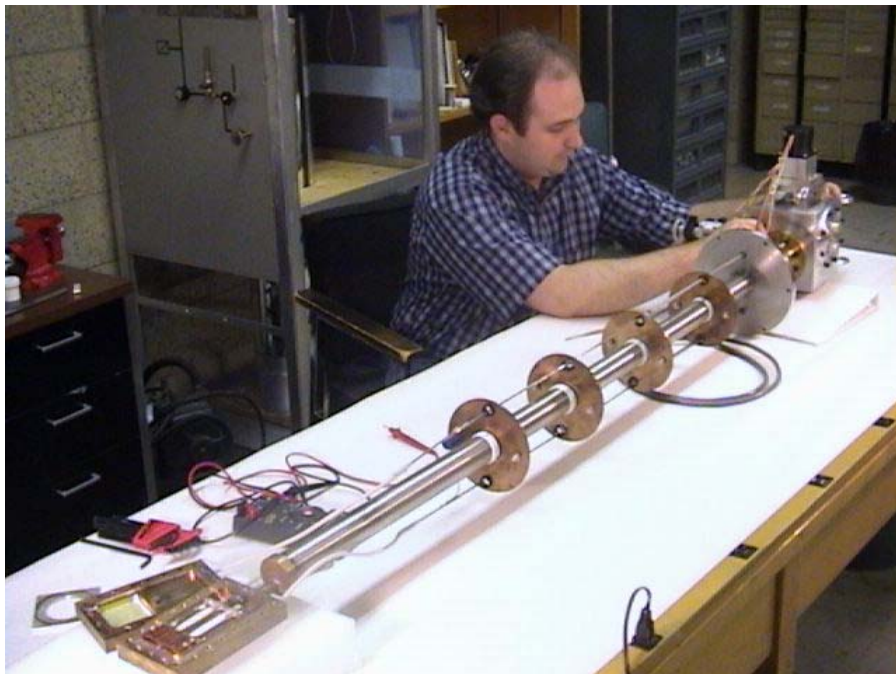
Vortices in a Type-II Superconductor. Electric charge is expelled from the non-superconducting core of the vortex into the surrounding superconducting condensate. This project is measuring, for the first time, the amount of expelled charge.

If a vortex carries an electric charge, then a moving vortex carries an electric current. Certain experiments have always hinted that a vortex charge might exist, but extracting the contributions of the vortex effects from the measurement currents has always been a hurdle. The key to isolating the vortex contribution is the use of **mobile flux**. By mechanically driving the vortices, we create a current from the vortices themselves **in the absence of any external currents**. A homogenous background field allows us to circumvent the short-circuiting effect of the surrounding superconductor, and measure a voltage which can **only** be attributed to the moving charge in the vortex core.

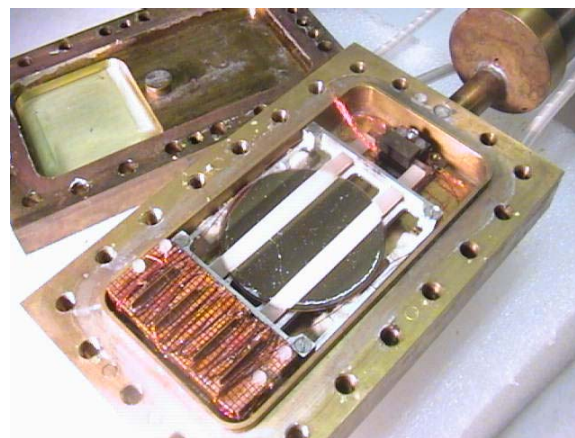


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Left: Ph.D candidate Thomas Fleming adjusts the motorization. Below: a closeup view of the superconducting sample and measurement system.



Students and Collaborators

- Thomas S. Fleming (dissertation research)
- M. J. Skove

Outreach

- Special lectures for Ukrainian physics students (Clayhold)
- Superconductivity Survey for Undergraduates (Fleming)

Educational Impact & Skills Acquired

- Precision measurement
- Nanovolt detection
- Mechanical, electrical and cryogenic design
- Data acquisition
- Superconductivity